



Organizational Results Research Report

June 2008  
OR08.019

# Assessment of Driver Recognition of Flashing Yellow Left-Turn Arrows in Missouri

Prepared by  
Missouri Department of  
Transportation

**FINAL REPORT**

RI08-020

# Assessment of Driver Recognition of Flashing Yellow Left-Turn Arrows in Missouri

Prepared for  
Missouri Department of Transportation  
Organizational Results

by  
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The opinions, findings, and conclusions expressed in this publication are those of the principal investigators. They are not necessarily those of the Missouri Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration. This report does not constitute a standard or regulation.

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16. Abstract This report documents the results of a study of flashing yellow left-turn arrow indications. The goal of the study was to determine driver understanding of the flashing yellow left-turn indication. Based on the results of this study, it is recommended to proceed with caution in the installation of flashing yellow left-turn indications at more locations around the state. A public information campaign should be initiated in order to increase familiarity with the signal prior to and during the implementation process.			
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# Executive Summary

In order to determine driver comprehension of permissive left-turn indications, a study was conducted in Creve Coeur, Missouri. The study was conducted in April 2008 to examine drivers in the area surrounding intersections with flashing yellow left-turn arrow indications (FYA). The survey consisted of several image questions and presented respondents with driving situations and asked the correct way to obey left-turn signals while proceeding through intersections.

The results of the survey show that the “left turn yield on green” indication with the R10-12 sign is better understood than the FYA indication. The FYA question averaged correct responses 72.4 percent of the time, whereas the “left turn yield on green” question was answered correctly 94 percent of the time.

More concerning was the tendency of respondents, who did not know the correct answer, to choose a potentially dangerous action. More than half of the time, respondents answered “GO” over “STOP” when they did not know the answer was “YIELD”.

The age of the respondent also affected correct responses, with more experienced drivers scoring higher. The “under 24” age group consistently answered more questions incorrectly as compared to the other age groups. The most consistent correct responses came from the age ranges of 24 - 44 and 45 - 65.

Exposure to the FYA indication did improve correct responses. Those who indicated that they had seen the flashing yellow left-turn indication while driving consistently answered the FYA questions correctly more often than those who had not seen the FYA signal before. Still, both groups understood the comparable “left turn yield on green” question better than the FYA indication question.

Based on the results of this study, it is recommended to proceed with caution in the installation of flashing yellow left-turn indications at more locations around the state. A public information campaign should be initiated in order to increase familiarity with the signal prior to and during the implementation process.

# Purpose

The purpose of this study was to determine if drivers in an area with flashing yellow left-turn arrow indications understand the flashing yellow left-turn arrow. The study also compared the understandability of the flashing yellow left-turn arrow to the “left turn yield on green” indication.

## Methodology

### Respondents

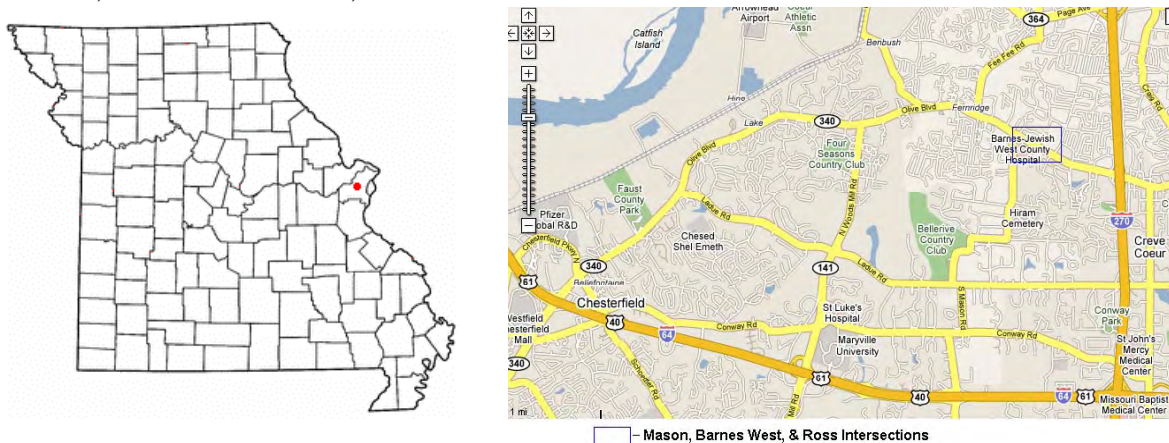
This study examined drivers in the areas surrounding the intersections with flashing yellow left-turn arrow indications (FYA). Respondents were ages 15 and older. There were no restrictions on respondents other than age (only those people of driving age were asked to participate).

The total number of respondents was 204.

### Sampling Design

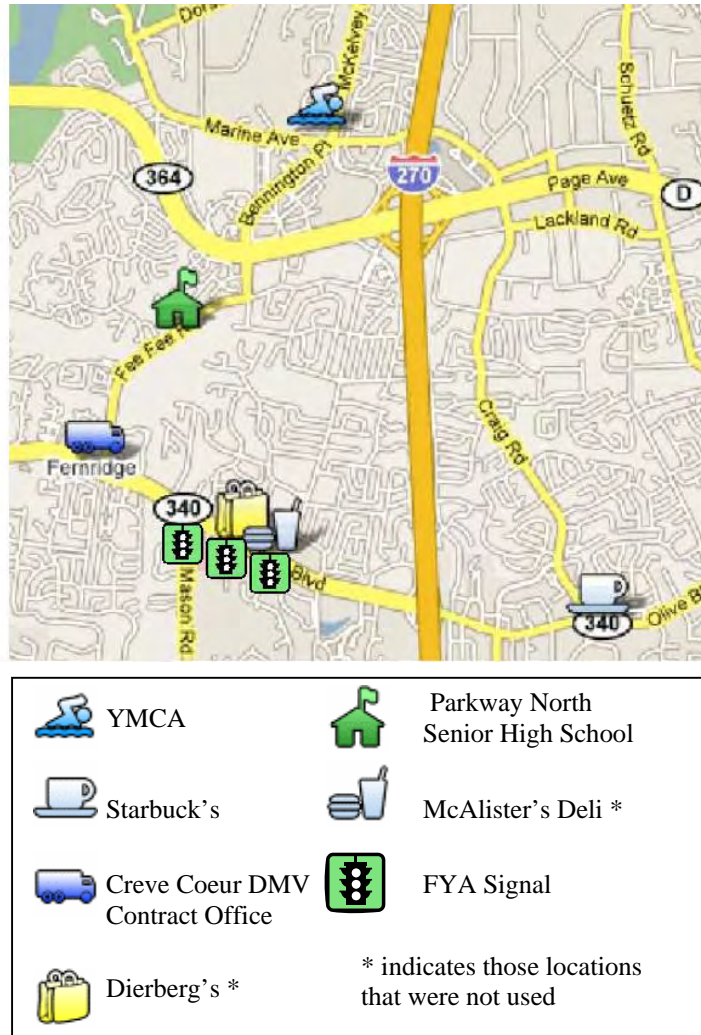
The target population for this study included the residents of Creve Coeur, Missouri as well as drivers from other areas who travel through Creve Coeur. In order to properly study this population, locations were selected to maximize both randomization (to fit statistical assumptions) and interspersed (to represent the entire study area).

Locations were selected prior to conducting the survey. Figure 1 shows the locations of the FYA indications and Figure 2 shows the locations planned for the study.<sup>1</sup> Locations were selected based on their relation to the intersections with the FYA indications. These intersections are located at MO 340 (Olive Boulevard) and Mason Road, Barnes West Road, and Ross Road.



**Figure 1 - Locations of the FYA Intersections**

<sup>1</sup> Please note that some of the planned locations were not utilized due to inclement weather.



**Figure 2 - Locations Planned for the Study**

Prior to completing the study, a target of 200 respondents was set. The population for the study was enumerated using two factors: 1) number of vehicles traveling through the FYA intersections by time and day of the week, and 2) number of licensed drivers in Creve Coeur by total number and age.

The number of vehicles traveling through the intersections was determined based on data collected from a permanent counter at MO 340 and Ross Road. The data collected from the year 2007 was used. Using east and westbound data, an average number of vehicles traveling through the intersections during the days and times of the survey was compiled. The results are as follows:

Survey Day 1 – Saturday – 8:00 am – 3:00 pm  
 Average Traffic Volume – 9,851  
 Number of Respondents – 86  
 Confidence Interval (95%)  $\approx 10.5$

Survey Day 2 – Sunday – 8:00 am – 1:00 pm  
Average Traffic Volume – 10,622  
Number of Respondents – 66  
Confidence Interval (95%)  $\approx 12$

Survey Day 3 – Monday – 8:00 am – 12:00 pm  
Average Traffic Volume – 14,132  
Number of Respondents – 52  
Confidence Interval (95%)  $\approx 13.5$

Total  
Average Traffic Volume – 34,605  
Respondents - 204  
Confidence Interval (95%)  $\approx 6.8$

The number of licensed drivers in Creve Coeur was determined based on Missouri Department of Revenue (DOR) numbers of St. Louis County licensed drivers. This number was extrapolated based on the percentage of St. Louis County residents who reside in Creve Coeur ( $\approx 1.7\%$  of the county's population). The results are as follows:

Under 24 years old  
DOR Licensed Drivers by Percentage – 1560  
Number of Respondents – 41  
Confidence Interval (95%)  $\approx 15$

24 – 44 years old  
DOR Licensed Drivers by Percentage – 4570  
Number of Respondents – 92  
Confidence Interval (95%)  $\approx 10$

45 – 65 years old  
DOR Licensed Drivers by Percentage – 4778  
Number of Respondents – 63  
Confidence Interval (95%)  $\approx 12$

65+  
DOR Licensed Drivers by Percentage – 1715  
Number of Respondents – 4  
Confidence Interval (95%)  $\approx 49$

Total  
DOR Licensed Drivers by Percentage – 12,623  
Number of Respondents – 204  
Confidence Interval (95%)  $\approx 6.8$



The confidence interval for both measures is 6.8. This means there is a 95 percent certainty that, if the entire population of drivers in Creve Coeur and at the FYA intersections were surveyed, the true data would fall  $\pm 6.8$  percent from the sample data.<sup>2</sup>

All of the categories show an acceptable confidence interval except for the 65+ age range. This group of the population was significantly underrepresented. The reason for this inadequate representation may be that the locations used were not frequented by the older population, or it could be because older licensed drivers do not drive as much as younger drivers.

## Questionnaire Design

This study was constructed to replicate a similar study published by the Transportation Research Board of the National Academies.<sup>3</sup> The basic design of the survey is based on that 2003 study. The survey was constructed using images of driving situations, and asked respondents to complete this sentence: “If you want to turn left and you see the signals shown, you would...” Answer choices for MoDOT’s study were “GO (you have right of way)”, “YIELD (wait for gap)”, and “STOP”. A complete copy of the survey can be found in Appendix A.

For time considerations, a total of six signal questions were asked. Also asked was a question regarding whether or not the respondent had ever seen the FYA signal while driving and a demographic question to determine the respondent’s age range.

The selection of the signal questions was based on the purpose of the study. There were two questions that featured the FYA indication, two comparative questions featuring the “left turn yield on green” signal with the R10-12 sign, and two control questions. Because the survey was designed and implemented using an online survey tool, the FYA indication questions could be animated to replicate the actual signal.

## Procedure

The study was conducted at various locations around Creve Coeur, Missouri on April 12 – 14, 2008. The study was presented to respondents via a laptop computer with wireless Internet access.

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<sup>2</sup> For example, if 75% of respondents said the answer was “GO,” then the actual percentage of the population that would say “GO” is somewhere between 68.2% ( $75 - 6.8$ ) and 81.8% ( $75 + 6.8$ ).

<sup>3</sup> Brehmer, et. al. (2003). *NCHRP Report 493: Evaluation of Traffic Signal Displays for Protected / Permissive Left-Turn Control*. Washington D.C.: Transportation Research Board of the National Academies.

Also noted: Knodler, Michael, et. al. (2006). “Potential Application of Flashing Yellow Arrow Permissive Indication in Separated Left-Turn Lanes”. *Transportation Research Record: Journal of the Transportation Research Board* (No. 1973, pp 10-17). Washington D.C.: Transportation Research Board of the National Academies.

At all locations, with the exception of the high school, MoDOT employees set up a table with chairs in the selected location. Two to three laptops were then set-up with the survey displayed. Signs were posted at the location indicating MoDOT's presence.

Depending on the day, two to three MoDOT Central Office and St. Louis Area District employees stood near the table with the laptops and asked passers-by if they would like to participate in a "short survey for MoDOT." Approximately half of the people approached agreed to complete the survey. After answering the questions on the laptop, respondents were given a brochure that explained the FYA signal and the answers to the survey questions.<sup>4</sup> In addition, respondents were given a complimentary item of their choosing and thanked for their time.<sup>5</sup>

At the high school, the survey was conducted with a driver's education class. Three laptops with wireless internet access were set up on school desks. Three MoDOT employees were in the classroom, along with the instructor. The students rotated in completing the survey while the MoDOT employees showed a video and discussed safe driving.<sup>6</sup>

## Results

The results of the survey have been divided into four sections: Overall, Filtered by Age, Filtered by Experience with FYA Signal Head, and Filtered by Correct and Incorrect Responses. The "Overall" results show the averages of all responses to each question. The "Filtered by Age" results show the averages of all responses for each age range. The "Filtered by Experience with FYA Signal Head" results show the averages of all responses broken down by whether or not the respondents indicated they had seen the FYA indication while driving. Finally, the "Filtered by Correct and Incorrect Responses" results show averages of all responses broken down by how the respondents answered other questions in the survey.

### Overall

There were a total of 204 respondents to the survey. Overall, more than half of the respondents selected the correct answer to the driving questions. Below are the overall results of the survey.

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<sup>4</sup> A copy of the brochure is available in Appendix B.

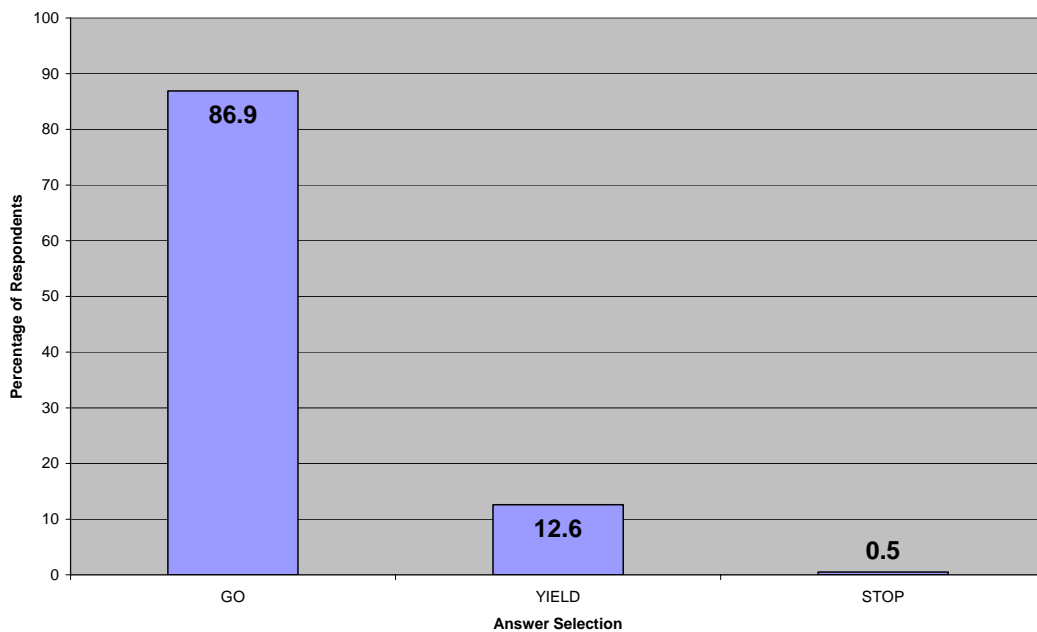
<sup>5</sup> Complimentary items included "Buckle Up" window clings, "Buckle Up" dog tag style necklaces, crayons with a coloring page, and 2008 MoDOT state road maps.

<sup>6</sup> The Drive Smart video was presented courtesy of the Missouri Coalition for Roadway Safety.

### Question 1 – 5-Section Signal Head with Green Ball and Green Arrow



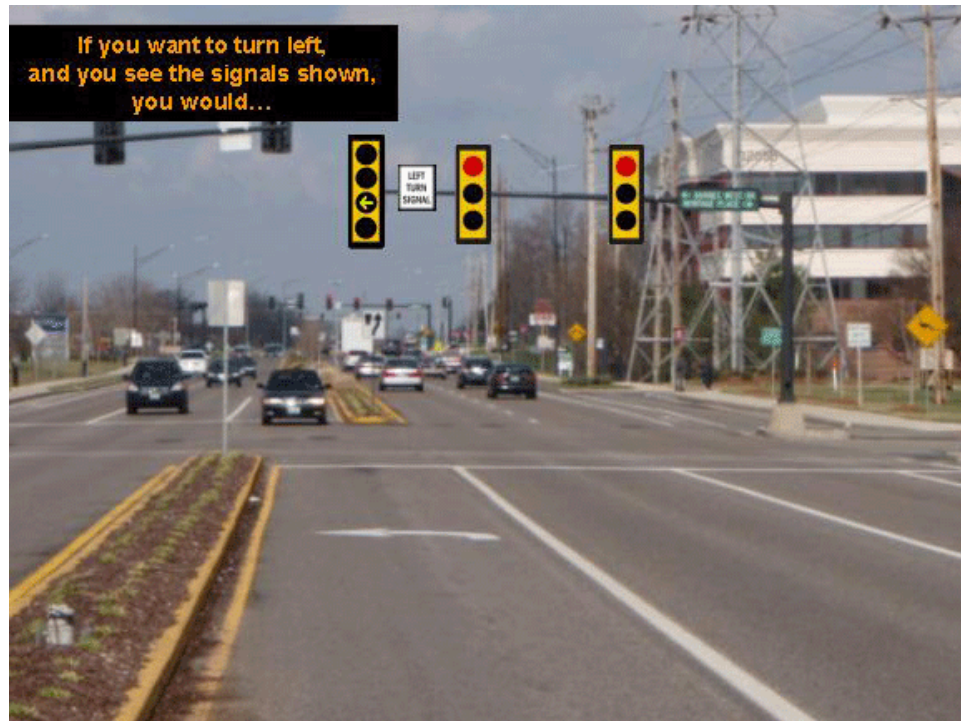
Question 1



**Figure 3 – Responses to Question 1**

Most respondents (86.9%) selected the correct response, “GO”. 12.6% of the respondents selected “YIELD”, and 0.5% chose “STOP”.

## Question 2 - FYA Signal Head with Red Thru Signals\*



\* The image was animated during the survey to replicate the flashing arrow.

Question 2

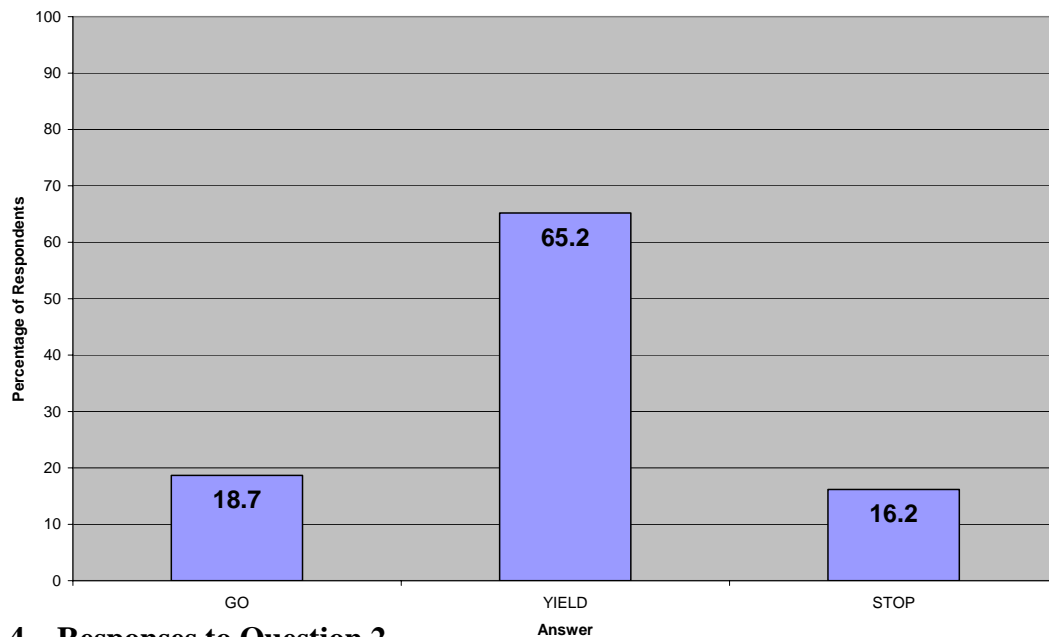


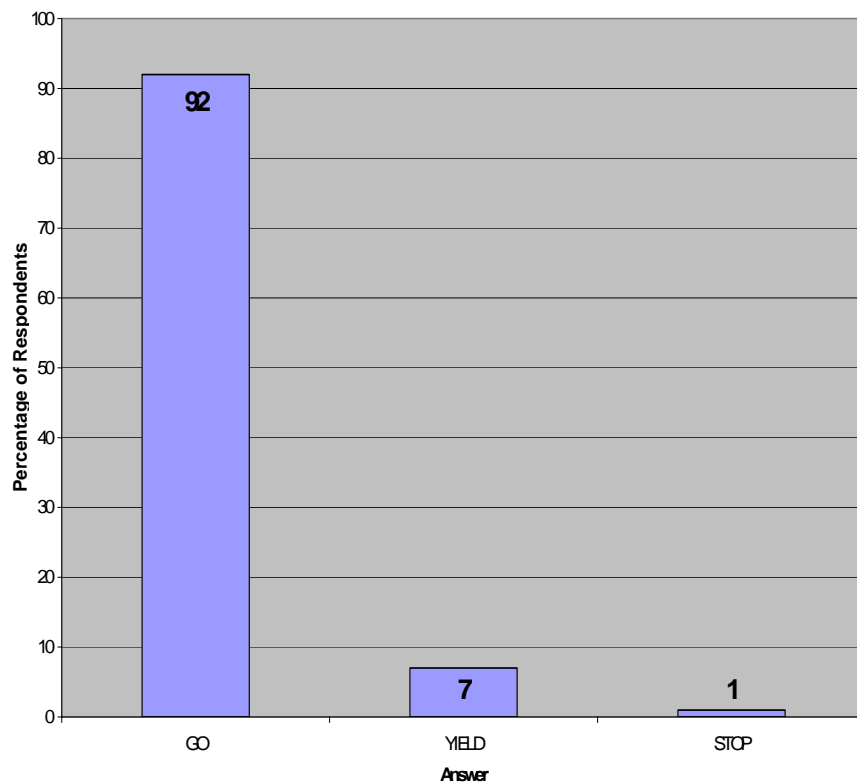
Figure 4 – Responses to Question 2

Most respondents (65.2%) selected the correct response, “YIELD”. 18.7% of the respondents selected “GO”, and 16.2% chose “STOP”.

### Question 3 - 4-Section Signal Head with Green Arrow and Red Thru Signals



Question3



**Figure 5 – Responses to Question 3**

Most respondents (92%) selected the correct response, “GO”. 7% of the respondents selected “YIELD”, and 1% chose “STOP”.



#### Question 4 - 4-Section Signal Head with Red Ball and Green Thru Signals



Question 4

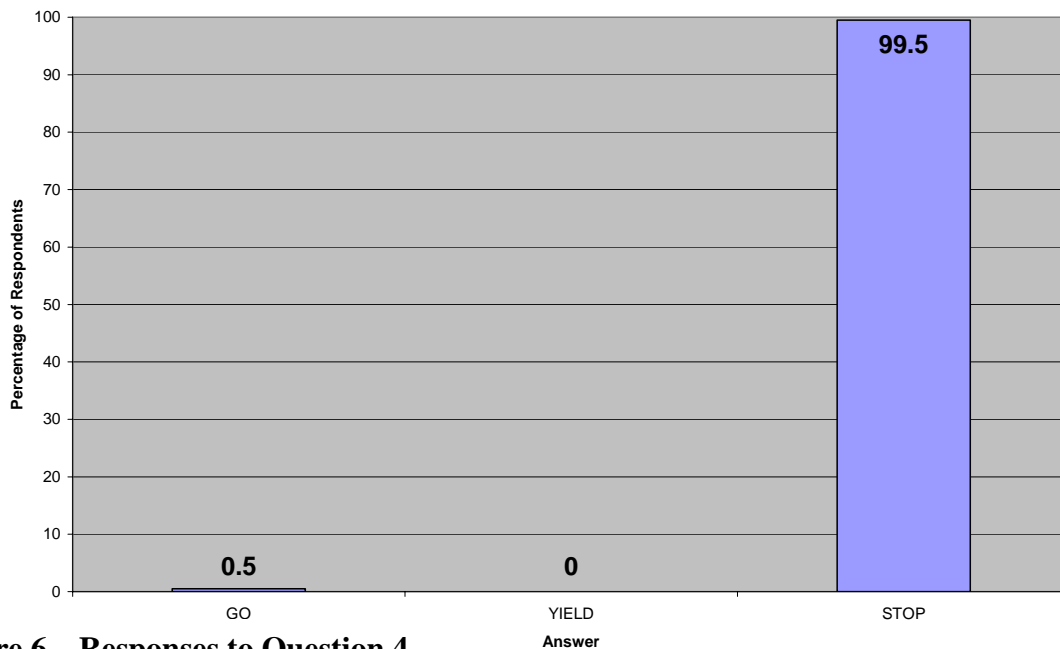


Figure 6 – Responses to Question 4

Most respondents (99.5 %) selected the correct response, “STOP”. 0.5% of the respondents selected “GO”, and none chose “YIELD”.

### Question 5 - FYA Signal Head with Green Thru Signals\*



\* The image was animated during the survey to replicate the flashing arrow.

Question 5

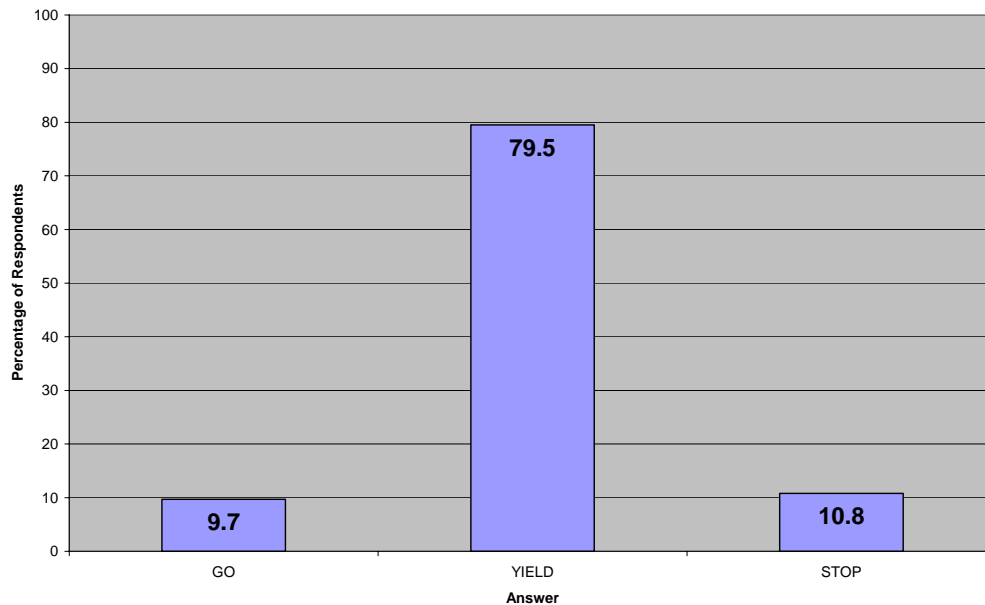


Figure 7 – Responses to Question 5

Most respondents (79.5%) selected the correct response, “YIELD”. 9.7% of the respondents selected “GO”, and 10.8% chose “STOP”.

### Question 6 – 5-Section Signal Head with Green Ball Only



Question 6

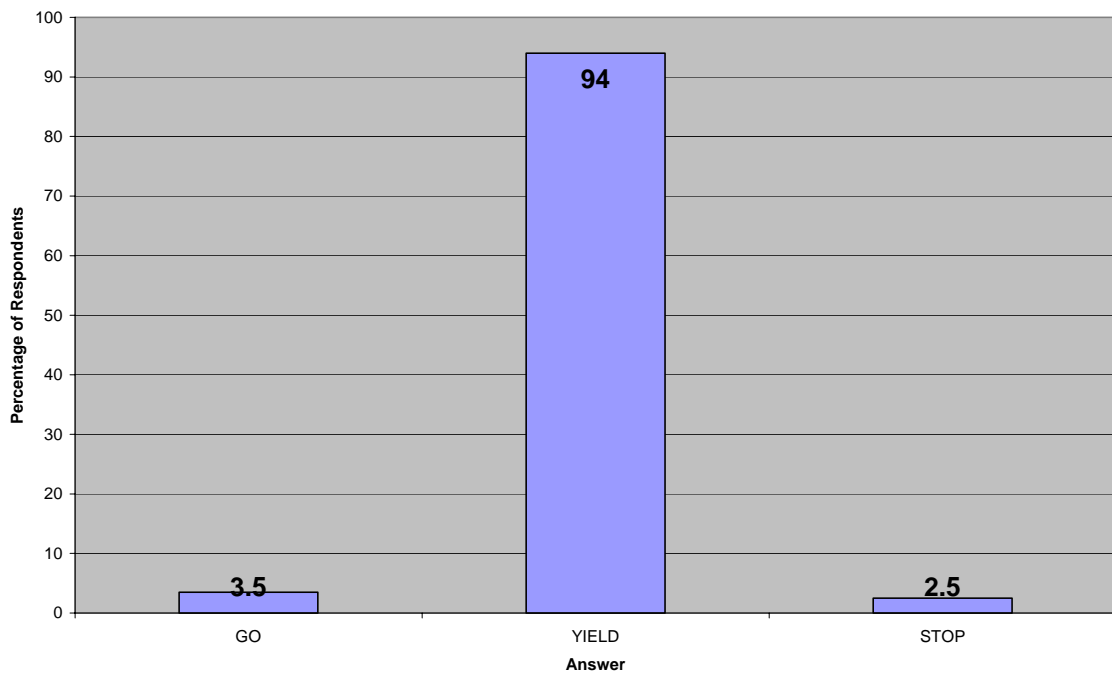


Figure 8 – Responses to Question 6

Most respondents (94%) selected the correct response, “YIELD”. 3.5% of the respondents selected “GO”, and 2.5% chose “STOP”.



Question 7 - Have you seen this signal while driving?\*



\* The image was animated during the survey to replicate the flashing arrow.

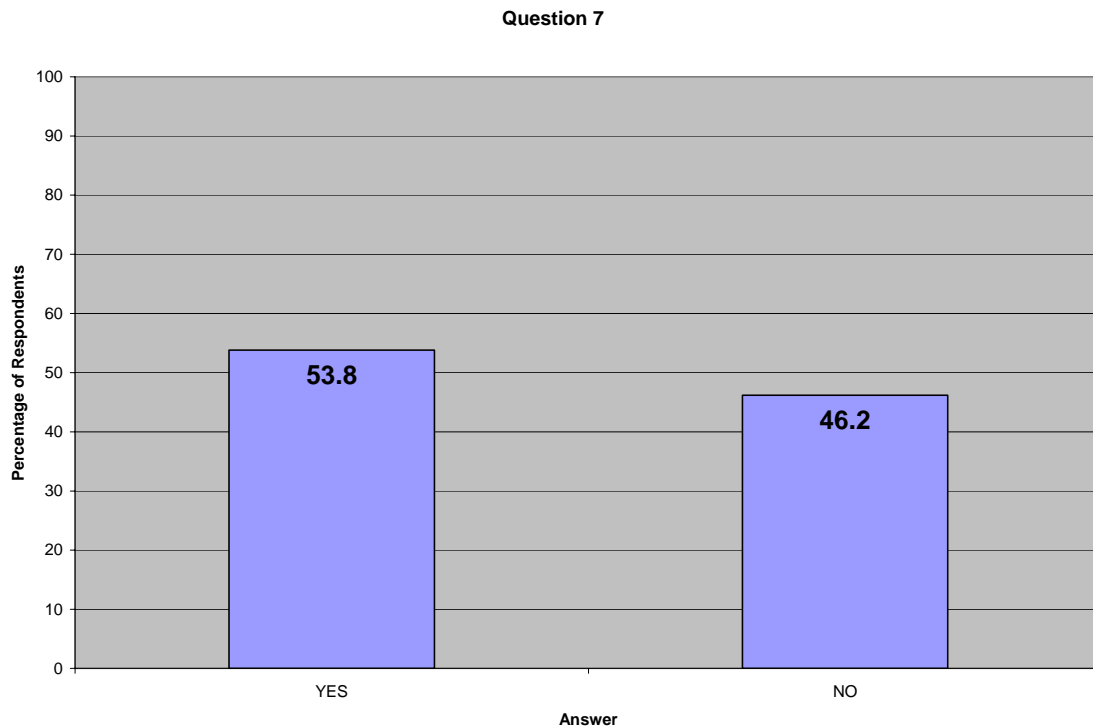


Figure 9 – Responses to Question 7

Most respondents (53.8%) indicated they had seen the signal, while 46.2% indicated they had not.

Question 8 – What is your age range?



Question 8

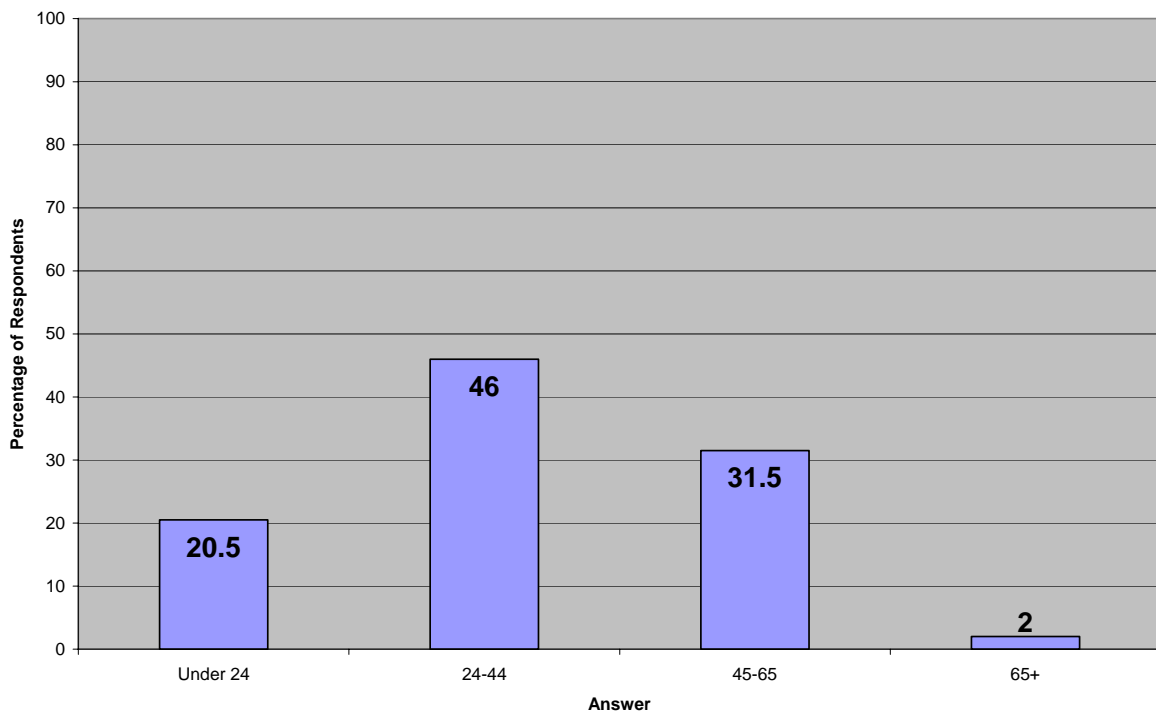


Figure 10 – Responses to Question 8

The majority of the respondents were age 24 - 44 (46%). 31.5% of respondents were age 45 - 65, 20.5% were under age 24, and 2% were age 65 or older.

## Filtered by Age

For those respondents under age 24, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 58.5%
- Q2 – FYA Signal Head with Red Thru Signals – 55%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals - 82.9%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 97.6%
- Q5 – FYA Signal Head with Green Thru Signals – 70%
- Q6 – 5-Section Head with Green Ball Only – 95.1%
- Q7 – Have you seen this signal while driving? – 53.7% said “YES”

For those respondents ages 24 - 44, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 96.7%
- Q2 – FYA Signal Head with Red Thru Signals – 75.8%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 94.6%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 82%
- Q6 – 5-Section Head with Green Ball Only – 93.5%
- Q7 – Have you seen this signal while driving? – 59.8% said “YES”

For those respondents under ages 45 - 65, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 91.4%
- Q2 – FYA Signal Head with Red Thru Signals – 60.7%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 93.5%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 80.6%
- Q6 – 5-Section Head with Green Ball Only – 96.8%
- Q7 – Have you seen this signal while driving? – 43.5% said “YES”

For those respondents ages 65 and over, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 100%
- Q2 – FYA Signal Head with Red Thru Signals – 25%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals - 100%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 100%
- Q6 – 5-Section Head with Green Ball Only – 50%
- Q7 – Have you seen this signal while driving? – 75% said “YES”

Correct Responses by Age Range

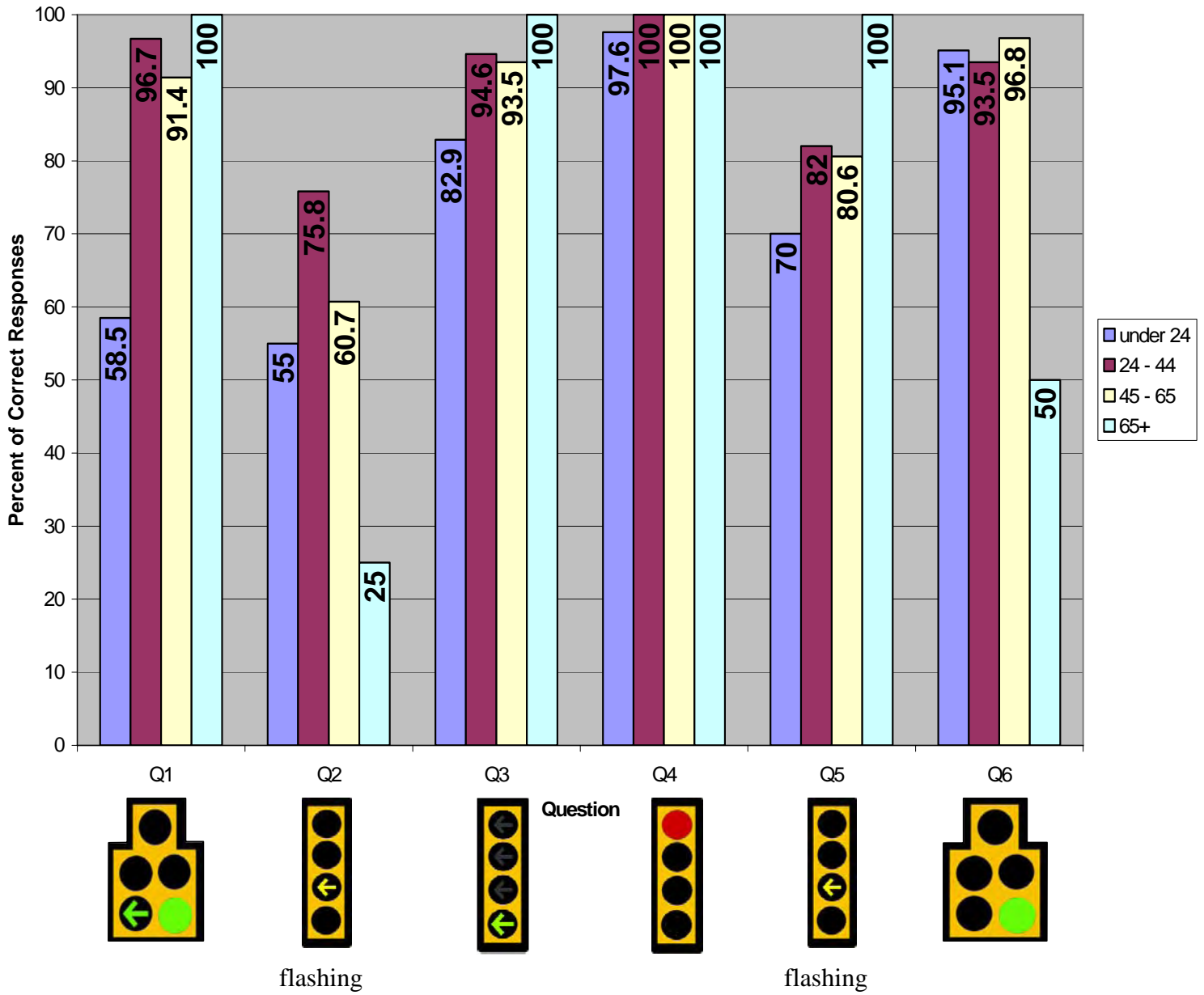


Figure 11 - Correct Responses by Age

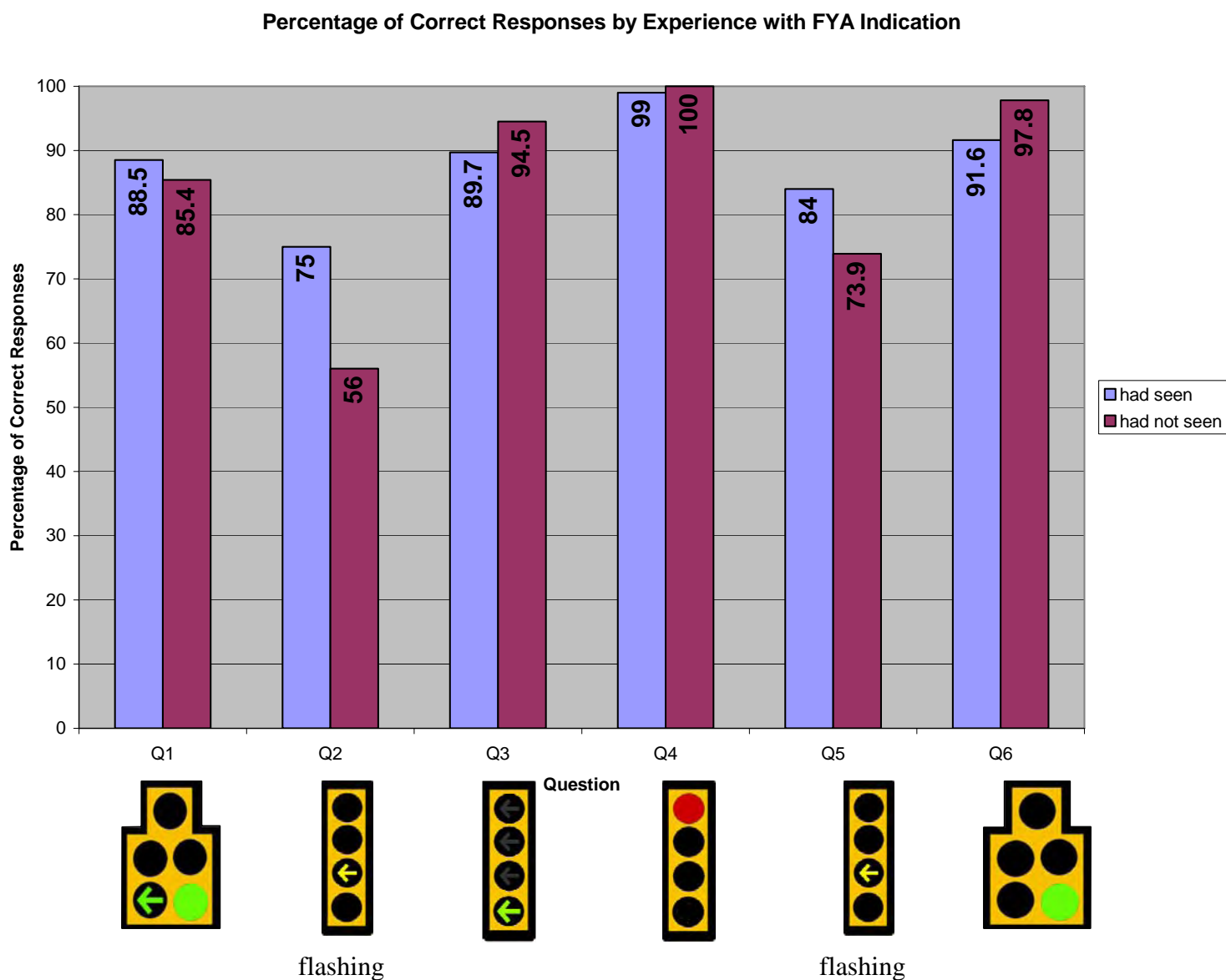
## Filtered by Experience with FYA Indication

For those respondents who indicated they had seen the FYA signal while driving, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 88.5%
- Q2 – FYA Signal Head with Red Thru Signals – 75%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 89.7%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 99%
- Q5 – FYA Signal Head with Green Thru Signals – 84%
- Q6 – 5-Section Head with Green Ball Only – 91.6%

For those respondents who indicated they had not seen the FYA signal while driving, the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 85.4%
- Q2 – FYA Signal Head with Red Thru Signals – 56%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 94.5%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 73.9%
- Q6 – 5-Section Head with Green Ball Only – 97.8%



**Figure 12 - Percentage of Correct Responses by Experience with FYA Indication**

## Filtered by Correct and Incorrect Responses

For those respondents who correctly answered the first FYA signal question (#2), the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 91.1%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 95.3%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 89.6%
- Q6 – 5-Section Head with Green Ball Only – 95.3%

For those respondents who correctly answered the second FYA signal question (#5), the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 89.3%
- Q2 – FYA Signal Head with Red Thru Signals – 74.2%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 93.5%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q6 – 5-Section Head with Green Ball Only – 92.9%

For those respondents who correctly answered the comparison signal question (#6), the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 87.9%
- Q2 – FYA Signal Head with Red Thru Signals – 66.8%
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 92.5%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 100%
- Q5 – FYA Signal Head with Green Thru Signals – 78.7%

For those respondents who incorrectly answered both FYA signal questions (#'s 2 and 5), the percentages of correct responses are as follows:

- Q1 – 5-Section Head with Green Ball and Green Arrow – 77.8%
- Q2 – FYA Signal Head with Red Thru Signals – 59.3% answered “GO”
- Q3 – 4-Section Signal Head with Green Arrow and Red Thru Signals – 85.2%
- Q4 – 4-Section Signal Head with Red Ball and Green Thru Signals – 96.3%
- Q5 – FYA Signal Head with Green Thru Signals – 55.6% answered “GO”
- Q6 – 5-Section Head with Green Ball Only – 96.3%

27 (13.2%) respondents answered both FYA questions incorrectly.

82 (40.2%) respondents answered at least one FYA question incorrectly.

112 (54.9%) respondents answered both FYA questions correctly.

172 (84.3%) respondents answered at least one FYA question correctly.

Percentage of Correct Responses by Responses to FYA Indication Questions

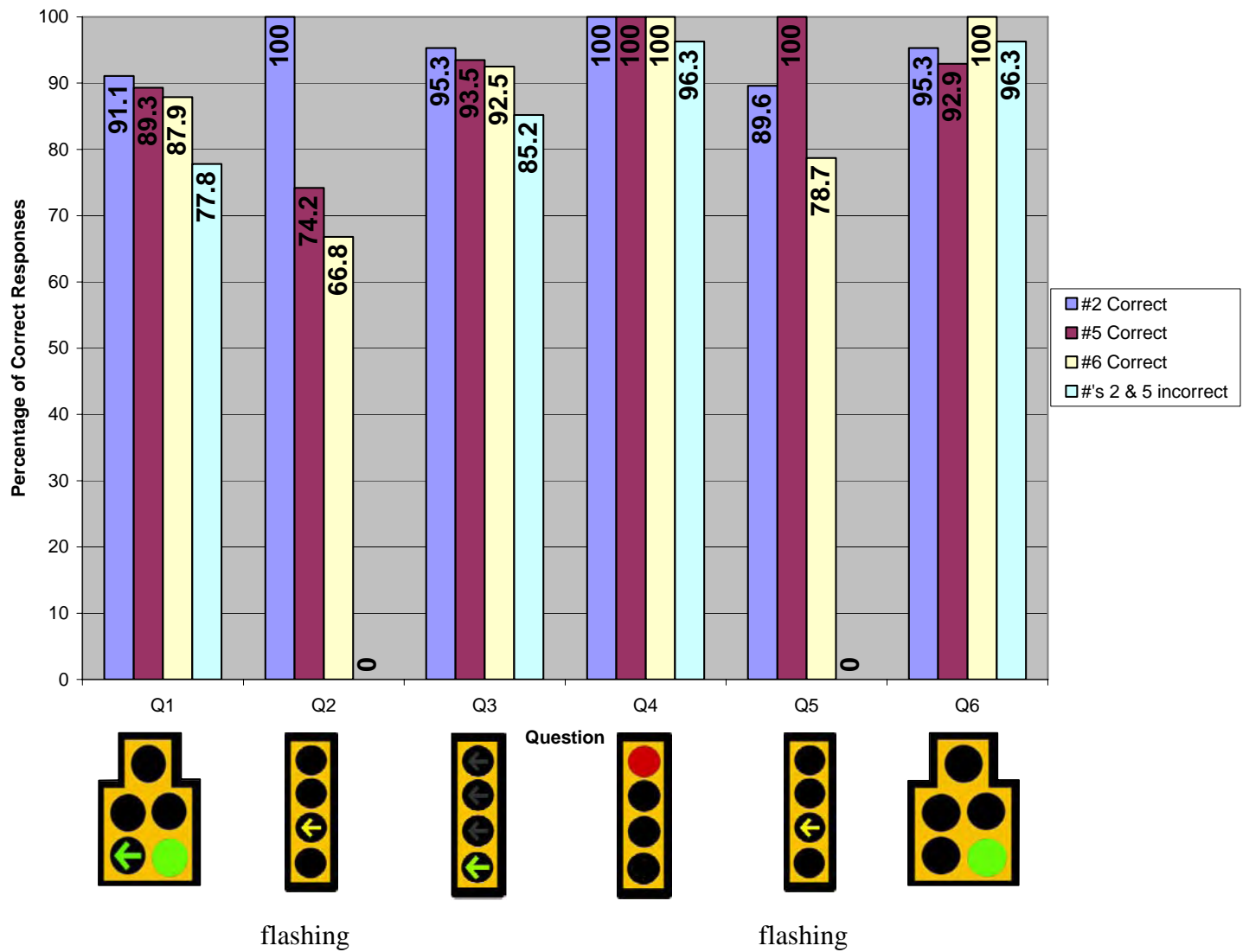


Figure 13 - Percentage of Correct Responses by Responses to FYA Indication Questions



## Appendix A: Survey



**For the following images,  
please complete this sentence:**

**If you want to turn left,  
and you see the  
signals shown,  
you would...**



jñ GO

You have right of way.

jñ YIELD

Wait for gap.

jñ STOP

If you want to turn left,  
and you see the signals shown,  
you would...



<sup>jn</sup> GO

You have right of way.

<sup>jn</sup> YIELD

Wait for gap.

<sup>jn</sup> STOP





jn GO

You have right of way.

jn YIELD

Wait for gap.

jn STOP



jn GO

You have right of way.

jn YIELD

Wait for gap.

jn STOP



jn **GO**  
You have right of way.

jn **YIELD**  
Wait for gap.

jn **STOP**



jn GO

You have right of way.

jn YIELD

Wait for gap.

jn STOP



**Have you seen  
this signal while  
driving?**



☐ YES

☐ NO



Your Age

☐ Under 24

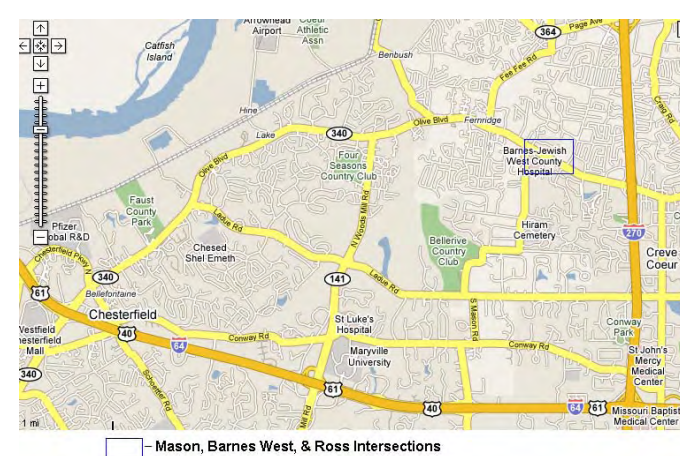
☐ 24-44

☐ 45-65

☐ Over 65

## Appendix B: “Flashing Yellow Left-Turn Arrow” Brochure





## Understanding the Flashing Yellow Left-Turn Arrow

*Remember: flashing yellow = turn with caution*



A solid red light means STOP. Drivers turning left must stop and wait.



A solid yellow arrow warns drivers that the left-turn signal is about to go to red and they should prepare to stop, or prepare to complete their left turn if they are within the intersection.



A flashing yellow arrow means turns are permitted, but you must first yield to oncoming traffic and pedestrians and then proceed with caution. Oncoming traffic has a green light.



A solid green arrow means it is safe to turn left. Oncoming traffic must stop.



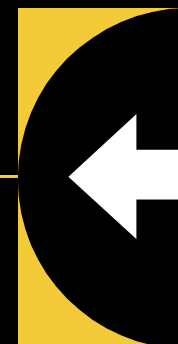
**Have you seen the Flashing Yellow Left-Turn Arrow while driving?**

**This type of light is currently only installed at 3 intersections in Missouri: 340 (Olive) at Ross Road, 340 at Barnes West, and 340 at Mason Road.**

For more information contact:

Missouri Department of Transportation  
888-ASK-MODOT (275-6636)  
[www.modot.org](http://www.modot.org)

# Flashing Yellow Left-Turn Arrow




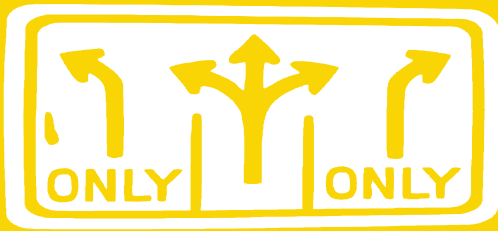
**Thank you for taking the  
time to complete MoDOT's  
survey!**

In the survey, you were shown a  
driving situation and asked to  
complete the sentence:

**"If you want to turn left,  
and you see the signals  
shown, you would..."**

The answer choices were: Go (you  
have right of way), Yield (wait for  
gap), and Stop.

On the following pages you will  
find the correct responses to the  
survey. Each correct response is  
marked with a .



**Go**

You Have  
Right of Way

**Yield**

Wait for Gap

**Stop**



**Go**

You Have  
Right of Way



**Yield**

Wait for Gap

**Stop**



**Go**

You Have  
Right of Way

**Yield**

Wait for Gap

**Stop**



**Go**

You Have  
Right of Way

**Yield**

Wait for Gap



**Stop**



**Go**

You Have  
Right of Way



**Yield**

Wait for Gap

**Stop**



**Go**

You Have  
Right of Way



**Yield**

Wait for Gap

**Stop**





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